

ELECTRICAL INTERFACES FOR USMC COMMONALITY

Prepared by

Program Manager - Expeditionary Power Systems

Marine Corps Systems Command



February 2007

Version 2.0

1.0 SCOPE

This document is provided to promote maximum commonality of electrical interconnections among future USMC equipment and for potential upgrades or preplanned product improvements (P3I) to existing equipment that includes electrical interconnections to external and/or remote systems.

Electrical interconnections internal to specific end items or weapons system is the purview of the cognizant Program Manager and/or System Integrator. However, commonality of connectors and wiring is highly desirable to produce consistent logistics across the Marine Corps and throughout the life cycle of the equipment.

2.0 APPLICABLE DOCUMENTS

Electrical interfaces are covered under a host of national and international standards and specifications. Listed below are applicable standards and specifications that benefit the Marine Corps in designing its electrical systems.

IEC 60309	International Electrotechnical Commission - Plugs, socket-outlets and couplers for industrial purposes
IEC 60529	International Electrotechnical Commission - Degrees of protection provided by enclosures
MIL-STD-1275	Characteristics of 28 Volt DC Electrical Systems in Military Vehicles - Revision D
MIL-STD-1332	Definitions of Tactical, Prime, Precise, and Utility Terminologies for Classification of the DoD Mobile Electric Power Engine Generator Set Family – Revision B
SL-3-6110	Marine Corps Stock List for the Mobile Electric Power Distribution System Replacement
STANAG 2601	NATO Standardization Agreement - Standardization of Electrical Systems in Tactical Land Vehicles
TM 12359A-OD	Principal Technical Characteristics Of U.S. Marine Corps Expeditionary Power Systems Equipment

3.0 PERFORMANCE REQUIREMENTS

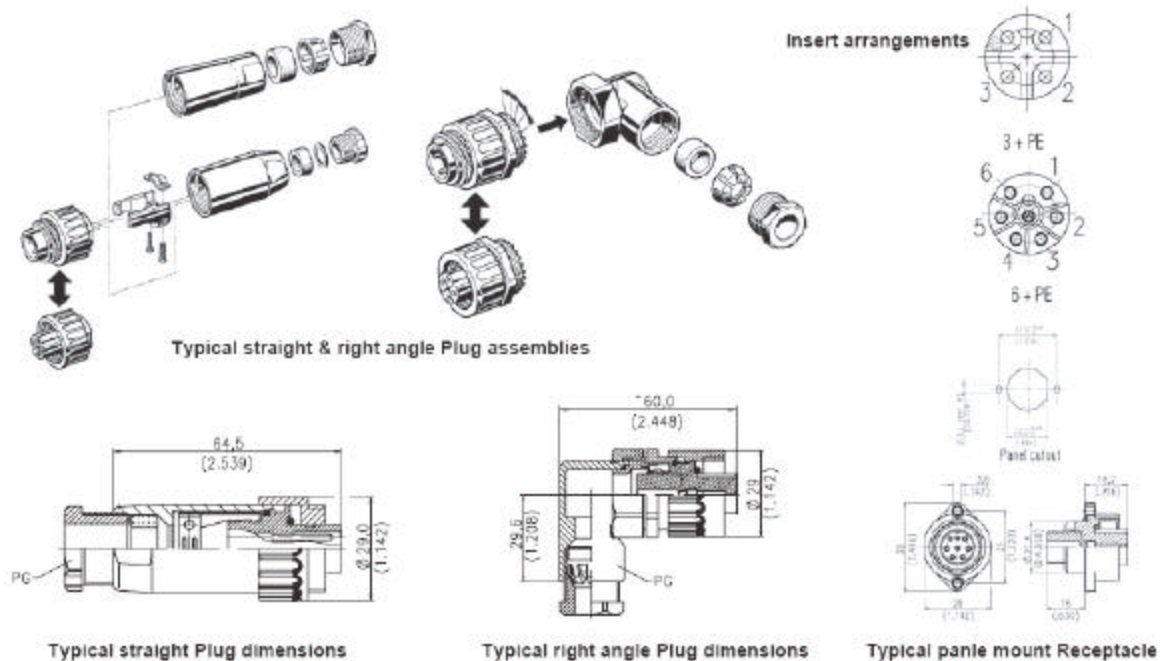
This document will address the two principle means for conducting electric power: Direct Current (DC) and Alternating Current (AC). Within each of those will be classes of power, usually defined by voltage transmission range.

With the new family of Mobile Electric Power Distribution Systems (MEPDIS), cabling specification for operation in a wide set of environmental conditions has become critical, and will also be discussed below.

3.1 Direct Current Systems (DC)

3.1.1 Low Power (5-40 VDC, up to 15 Amps)

The USMC is moving toward adoption of a set of robust circular connectors for low power transmission of 12 volt DC (VDC) and 24 VDC. The “Eco-Mate” C16 series of circular industrial connectors manufactured by Amphenol-Tuchel Electronics¹ were selected based on their construction that offers environmental robustness and Ingress Protection (IP), as defined by IEC 60529, to levels of IP65 or IP67 (depending on model)². A representation of the connector is shown below:



These connectors feature a vibration-proof coarse-threaded cable gland and are ergonomically shaped to facilitate quick mating/unmating even under extreme environmental conditions.

The series consists of male and female panel-mount receptacles, together with male and female cable connectors in both straight and right-angled versions. All variants are equipped with a pre-mating earth contact and can be specified with either three or six additional contacts in a choice of screw, solder or crimp termination styles. The USMC standard is three contacts plus ground. The pin-out connection template is:

Pin	Connection
PE	24 VDC ground
1	12 VDC positive
2	24 VDC positive
3	12 VDC ground

¹ Commercial vendor reference is available at www.amphenol-tuchel.com

² Definitions for Ingress Protection can be found in Appendix A

The following models are recommended for the types of potential application:

Model Number	Configuration	Application
C01620H00311012	Male Connector (Straight)	Receiving power
C01620D00311012	Female Connector (Straight)	Providing power
C01620G00311012	Female Receptacle	Providing power
C01620C00311012	Male Receptacle	Receiving power

For an application that has a rechargeable battery installed to receive or provide power, the female connector should be utilized.

According to UL rating E63093, this connector series can carry up to 250 Volts at 12 amps. The cable connectors incorporate a clamping ring that can accommodate cable diameters ranging from 6.0 to 12.5mm, and the straight versions are also available with an optional internal strain relief mechanism. All receptacles feature an integral fastener for the optional protective cap.

Provided in Appendix B is Original Equipment Manufacturer (OEM) data for these connectors.

Potential Sources of supply for purchase of these items is the following:

<http://dkc3.digikey.com/PDF/T071/0318.pdf>

<http://www.mouser.com/catalog/628/1059.pdf>

3.1.2 Medium Power - Stationary Applications (18-40 VDC, up to 60 Amps)

The USMC currently maintains in its inventory the Ruggedized Power Supply (RPS) with Table of Authorization Control Number (TAMCN) A7705 which provides regulated DC output for non-protected environments, and the Benchtop Power Supply (BPS) with TAMCN A7706 for protected environments.

The RPS provides its output via a front panel J2 output a Cannon Type MS-3102R22-2S socket. Supplied with the RPS is a Cannon Type MS-3106F22-2P connector as an over pack.

The RPS output connection is wired as follows:

Pin	Connection
A	DC Positive
B	Chassis Ground
C	DC Minus

The BPS provides its output via industry standard POS(red) & NEG(black) “Banana” plugs.

3.1.3 Medium Power - Mobile Applications (24-28 VDC, amperage level vehicle dependent)

NATO Standardization Agreement (STANAG) 2601 “Standardization of Electrical Systems in Tactical Land Vehicles” is an overarching policy to standardize key electrical systems among NATO signatories. The key attribute of this system is the agreement that the electrical systems

of all tactical land vehicles shall be 24 volts nominal direct current.

A common interface to the vehicle electrical system is the “NATO Slave Receptacle”, Military Part Number 11682345 and National Stock Number 5935-01-044-8382. Numerous sources of supply exist and be found via an internet search for plugs and receptacles. These connectors can carry up to 350 amps, with transients of up to 500-1000 amps (as seen during engine starting).

It should be noted that the NATO Slave Receptacles and Plugs are not durable connections while vehicles are in motion. A positive locking plug and receptacle that are rated for the anticipated amperage level should be utilized.

Military Standard 1275B is the controlling standard for 24-28 VDC electrical systems in tactical and combat vehicles, and should be referenced for greater description of range and capability for vehicle based systems.

3.1.4 Large Power (above 40 VDC)

For DC applications of very large amperage draw, safety and protection of personnel and equipment is the overriding concern in establishing electrical interconnections.

There are no known USMC applications for high amperage (hundreds of amps) or high voltage (greater than 40 VDC) power, either stationary or mobile, that have routine interconnection / disconnect application.

In the event that applications do arise, utilization of CAM Locks, as described in the following sections under AC High Power, would be the recommended means for connection.

3.2 Alternating Current Systems (AC)

Military Standard 1332B is the controlling standard for AC tactical electrical systems and should be referenced for greater description of range and capability of power generation sources.

The Program Manager – Expeditionary Power Systems (PM EPS) web site provides a description of USMC fielded items. The address is <http://www.marcorsyscom.usmc.mil/sites/pmeps>.

Technical Manual 12359A-OD “PRINCIPAL TECHNICAL CHARACTERISTICS OF U.S. MARINE CORPS EXPEDITIONARY POWER SYSTEMS EQUIPMENT” defines and describes the current equipment in the USMC inventory. This document is available at the above website.

3.2.1 Low Power (120 VAC, up to 20 Amps)

For indoor or outdoor applications, NEMA 5-15P or 5-20P plugs and NEMA 5-15R or 5-20R receptacles are recommended for commonality with the National Electric Code (NEC) and the National Fire Protection Agency (NFPA). Applications up to 15 amps can use straight blade plugs and receptacles. Above 15 amps and up to 20 Amps require the T-blade on the white-neutral lead.

Ground Fault Circuit Interrupting (GFCI) receptacles are recommended for AC outlets, with the exception that GFCI type receptacles should not be used in critical care patient areas or for electrical life support equipment applications because of the possibility of power interruption.

3.2.2 Medium Power (120/208 VAC, up to 100 Amps)

The USMC is standardizing on Pin and Sleeve connectors that meet International Electric Code (IEC) 60309 for electric current of 100 Amps or less. IEC 60309 is an international standard from the International Electrotechnical Commission for "plugs, socket-outlets and couplers for industrial purposes". The highest voltage allowed in the standard is 690 volts DC or AC, the highest current 250 amperes, and the highest frequency 500 hertz. The temperature range is -25 °C to +40 °C.

The Marine Corps utilizes a 3-phase, 5-wire system, with separate ground conductors and neutral.

NOTE: The US Army uses a 3-phase, 4-wire system, without separate ground from neutral, but tactical generators are provided with 5 load studs that include neutral and ground.

The following wiring arrangement for 5-wire systems shall be followed:

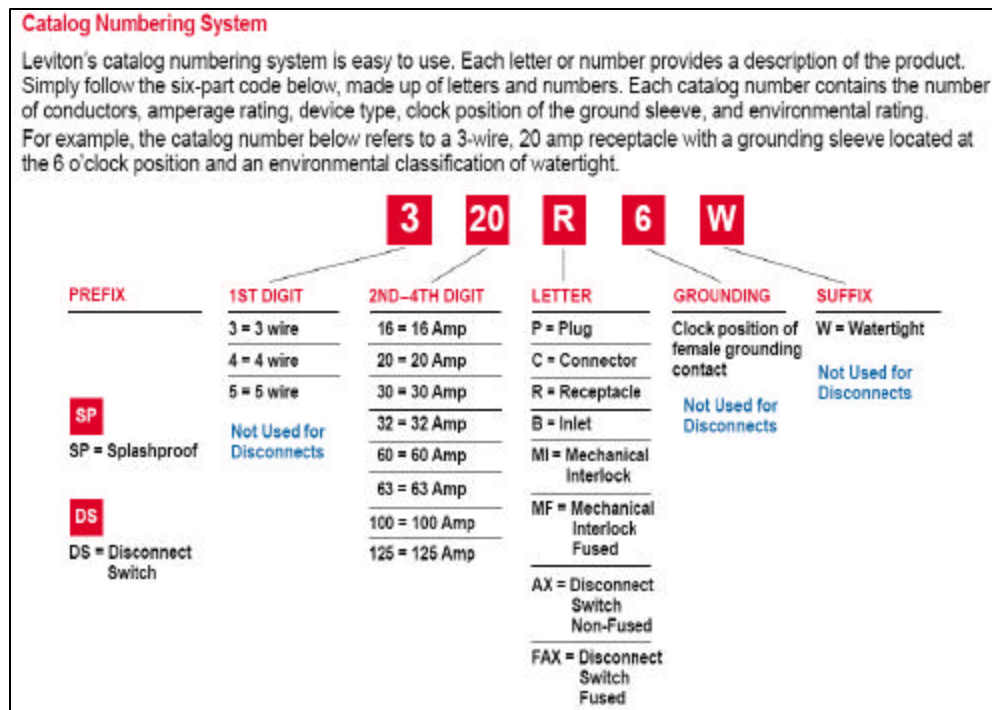
Conductor	Color
Ground	Green
Neutral	White
Phase A	Black
Phase B	Red
Phase C	Blue

The following universal part numbers exist for single-phase and 3-phase components.

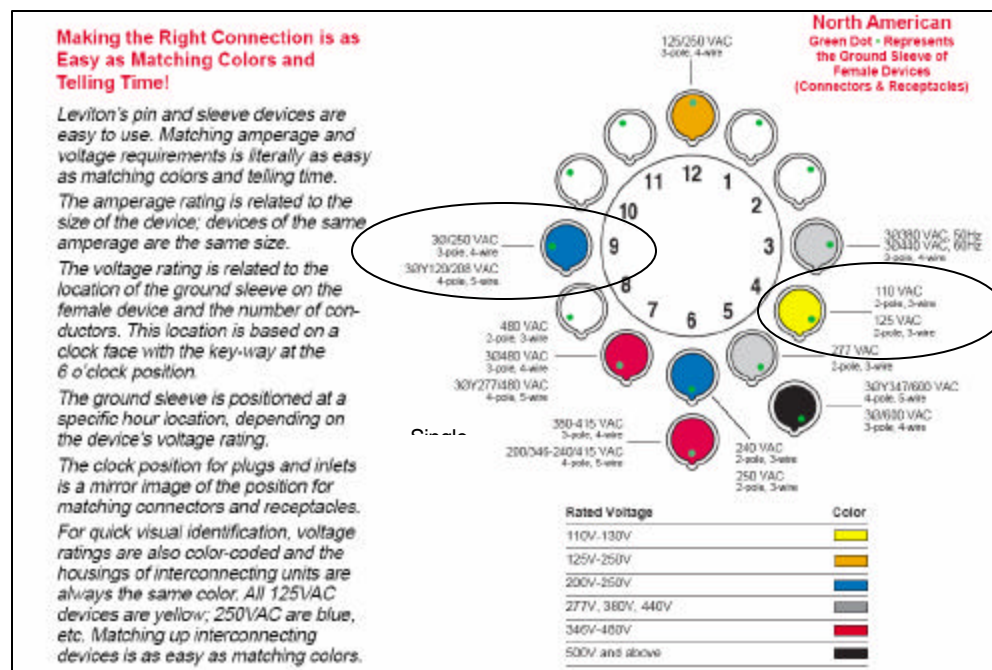


TYPE	Current Rating	Rating color	Receptacle P/N	Inlet P/N	Plug P/N	Connector P/N
1-Phase, 3 wire, 100-130 V						
1P 3W	15	Yellow	316R4W	316B4W	316P4W	316C4W
1P 3W	20	Yellow	320R4W	320B4W	320P4W	320C4W
1P 3W	30	Yellow	330R4W	330B4W	330P4W	330C4W
3-Phase, 5 wire, 120/208 V						
3P-5W	20	Blue	520R9W	520B9W	520P9W	520C9W
3P-5W	30	Blue	530R9W	530B9W	530P9W	530C9W
3P-5W	60	Blue	560R9W	560B9W	560P9W	560C9W
3P-5W	100	Blue	5100R9W	5100B9W	5100P9W	5100C9W

All vendors follow a universal catalog numbering system for this class of connectors, making the system logistically easy to support in a worldwide environment. Marine Corps Stock List SL-3-6110 for the “Mobile Electric Power Distribution System Replacement” provides a list of supply for these connectors. An example of one vendor’s product literature is provided below.



The Marine Corps utilization of IEC60309 connectors follow the nomenclature for female grounding contact at the 4:00 o'clock position for 125 VAC 3-wire applications, and at the 9:00 o'clock position for 120/208 VAC 5-wire applications.




3.2.3 Large Power (120/208/240/416 VAC, up to 600 Amps)

For large applications where 5-wire cables are necessary to handle the amperage load would be too heavy, individual phase wires will be used and terminated with Cam Loc Type 16 connectors. These are single conductor connectors and come in two sizes: 2-0 cables, and 4-0 to 1-0 cables.

Similar to IEC 60309 connectors, these are supportable worldwide. An example of one vendor's product literature is provided below that shows the capability of the connectors. Marine Corps Stock List SL-3-6110 for the "Mobile Electric Power Distribution System Replacement" provides a list of supply for these connectors.

Leviton Catalog #: 16D31-R
Description: Female, Plug, Detachable, Double Set Screw, 2-2/0 AWG, 300 Amp Max., 16 Series Taper Nose, Commercial Grade, ECT Cam-Type Connector - Red

16 SERIES - TAPER NOSE Double Set Screw Plug Connector



Product Features:

- Gender: Female
- Style: Detachable
- Connection Type: Double Set Screw
- Cable Range: 2-2/0 AWG
- Max Amperage: 300 Amp
- Max Voltage: 600 Volt
- Color: Red

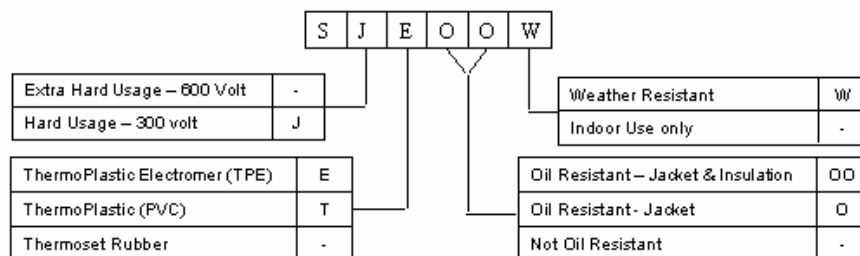
Standards And Certifications: UL/CSA

Warranty: NA
Series: 16
Component: Complete
Contact Cat. No.: 16D31-C
Insulator Cat. No.: 16SDF-22R

2 - 2/0 AWG 300 AMP 600 VOLT FEMALE RED

3.3 Cabling

Cabling for systems should be flexible and adhere to NEC characteristics. Provided below is a description of how cabling is specified:



For external USMC applications where AC transmission in a harsh environment is planned, SEOOOW cable is recommended. For DC application that does not have as high of voltage rating, SJEOOW is suitable. SJEOOW has had durability problems at EXTREME low temperatures, but should be adequate for most general purpose applications.

Cable assembly conductor and ground wire resistance should not exceed the following:

Cable Assembly Length	Maximum Resistance
25 feet	0.06 OHMS
50 feet	0.12 OHMS

4.0 POINTS OF CONTACT

Within the Marine Corps Systems Command, the following are points of contact for this information:

John O'Donnell, (703) 432-3768, john.h.odonnell@usmc.mil

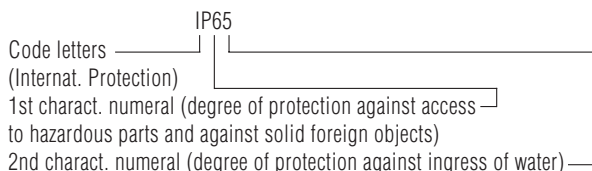
APPENDIX A

INGRESS PROTECTION DEFINITIONS

Degree of Protection

Electrical devices to which connectors belong to have to be protected for safety reasons from outside influences like dust, foreign objects, direct contact, moisture and water. This protection is provided on industrial connectors by its housings with their latching devices and sealed cable entries. The degree of protection can be selected depending on the type of intended use. The standard IEC 60529 and/or DIN EN 60529/VDE 0470 Part 1 has specified the degree of protection and divided into several classes.

The degree of protection is indicated in the following way:



The following charts 4 and 5 give an overview about all protection degrees.

Chart 4

1st charact. numeral	Brief description	Definition
0	Non-protected	—
1	Protected against access to hazardous parts with the back of a hand. Protected against solid foreign objects of $\geq 50\text{mm } \varnothing$.	The probe, sphere of 50mm \varnothing , shall not fully penetrate and shall have adequate clearance from hazardous parts.
2	Protected against access to hazardous parts with a finger. Protected against solid foreign objects of $\geq 12,5\text{mm } \varnothing$.	The jointed test finger of 12mm \varnothing , 80mm length, shall have adequate clearance from hazardous parts. The probe, sphere of 12,5mm \varnothing , shall not fully penetrate.
3	Protected against access to hazardous parts with a tool. Protected against solid foreign objects of $\geq 2,5\text{mm } \varnothing$.	The probe of 2,5mm \varnothing shall not penetrate at all.
4	Protected against access to hazardous parts with a wire. Protected against solid foreign objects of $\geq 1\text{mm } \varnothing$.	The probe of 1mm \varnothing shall not penetrate at all.
5	Protected against access to hazardous parts with a wire. Dust-protected.	The probe of 1mm \varnothing shall not penetrate. Intrusion of dust is not totally prevented, but dust shall not penetrate in a quantity to interfere with satisfactory operation of the device or to impair safety.
6	Protected against access to hazardous parts with a wire. Dust-tight.	The probe of 1mm \varnothing shall not penetrate. No intrusion of dust.

Chart 5

2nd charact. numeral	Brief description	Definition
0	Non-protected	—
1	Protected against vertically falling water drops	Vertically falling drops shall have no harmful effects.
2	Protected against vertically falling water drops when enclosure tilted up to 15°	Vertically falling drops shall have no harmful effects when the enclosure is tilted at any angle up to 15° on either side of the vertical.
3	Protected against spraying water	Water sprayed at an angle up to 60° on either side of the vertical shall have no harmful effects.
4	Protected against splashing water	Water splashed against the enclosure from any direction shall have no harmful effects.
5	Protected against water jets	Water projected in jets against the enclosure from any direction shall have no harmful effects.
6	Protected against powerful water jets	Water projected in powerful jets against the enclosure from any direction shall have no harmful effects.
7	Protected against the effects of temporary immersion in water	Intrusion of water in quantities causing harmful effects shall not be possible when the enclosure is temporarily immersed in water for 30 min. in 1m depth.
8	Protected against the effects of continuous immersion in water	Intrusion of water in quantities causing harmful effects shall not be possible when the enclosure is continuously immersed in water under conditions which shall be agreed between manufacturer and user but which are more severe than for numeral 7.
9K ¹⁾	Protected against water during high pressure/steam jet cleaning	Water projected in powerful jets with high pressure against the enclosure from any direction shall have no harmful effects.

¹⁾ Remark: Numeral acc. to DIN 40050 part 9, vehicles IP code.

APPENDIX B

ECO MATE CONNECTOR SPECIFICATION DATA



Product Description

In design and conception the eco|mate^m program meets the high requirements for applications in industrial technology. Easy operation, reduced dimensions and a more robust design to withstand harsh conditions are only a few of the features of the series.

The connector's main area of application is in the fields of plant construction and machine building. The connector is principally used for measuring and controlling applications such as the control technology for motive engineering, but may also be used for medical. The series is comprised of a large selection of housings and shapes, as well as models with screw, solder and crimp termination.

Features:






- Circular Connectors with 3+PE and 6+PE contacts
- Housing components made from premium molding material
- Cable housing straight or angled
- Vibration safe connection through stable and non-sensitive screw locking
- Protection class IP 65/67 in mated condition in accordance with DIN EN 60526
- Clamping ring or internal strain relief

Advantages:

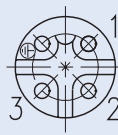

- Quick and easy assembly
- Screwed cable gland with clamping ring
- Strain relief and mounted gasket all in one component
- Cable housing, straight or angled, for the cable diameter 6 - 12,5 mm
- Robust thread for the screwed cable gland
- Ergonomically designed product range for safe handling, even under harsh working conditions
- Pre-loaded ground contact
- Fastening for the protective caps on the housing of the receptacles
- The eco|mate^m program is compatible and interchangeable with the C16-1 series

Additional standards:

- The 6+PE model corresponds to DIN 9684-1 interface to the signal transmission on agricultural machines and tractors
- Housing material is in accordance with DIN 5510, Part 2 the required behavior in the fire

Testhouse		Characteristics	Approval Number
VDE		3+PE, 400 V, 16 A 6+PE, 250 V, 10 A	1781 1780
SEV		3+PE, 400 V, 16 A 6+PE, 250 V, 6 A	00.0394
UL		3+PE, 250 V, 12 A 6+PE, 250 V, 8 A	E 63093
CSA		3+PE, 250 V, 12 A 6+PE, 250 V, 8 A (Solder version) 6+PE, 250 V, 15 A (Crimp version)	48932
German Llyod		3+PE, 250 V, 16 A 6+PE, 50 V, 8 A	14108 / 84

In general approvals refer to versions of the connector series. Test report upon request.

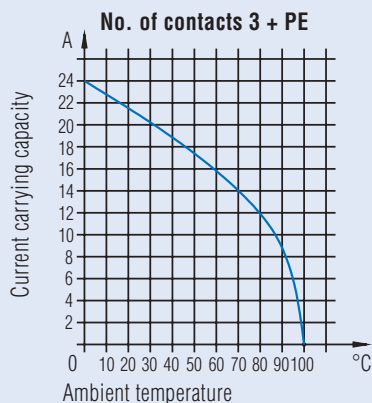
General Characteristics	Standard	Characteristics		
Number of contacts		3 + PE	6 + PE	
				
Electrical Characteristics		screw type	solder type	crimp type
Rated insulation voltage	DIN EN 60664-1 ¹⁾	400 V	250 V	250 V
Rated impulse withstand voltage	DIN EN 60664-1 ¹⁾	6000 V	4000 V	
Pollution degree	DIN EN 60664-1 ¹⁾	3	3	
Installation (overvoltage) category	DIN EN 60664-1 ¹⁾	III	III	
Material group	DIN EN 60664-1 ¹⁾	II	II	
Current carrying capacity	DIN EN 60512-5-2, Test 5b	16 A / + 55 °C	10 A / + 55 °C	13 A / + 55 °C
Insulation resistance	DIN EN 60512-3-1, Test 3a	≥ 10 ⁸ Ω	≥ 10 ⁸ Ω	
Contact resistance	DIN EN 60512-2-1, Test 2a	≤ 5 m Ω	≤ 5 m Ω	
Climatic Characteristics				
Climatic category	DIN EN 60068-1	40 / 100 / 56	40 / 125 / 56	
Operating temperature		-40°C ... +100°C	-40°C ... +125°C	
Mechanical Characteristics				
IP-degree of protection	DIN EN 60529	IP 65 / IP 67		
Insertion and withdrawal force	DIN EN 60512-13-2, Test 13b	≤ 15 N	≤ 30 N	
Mechanical operation	DIN EN 60512-9-1, Test 9a	≥ 500 mating cycles		
Materials				
Housing material		PA 6.6 / PA 6		
Dielectric material		PA 6.6 / PA 6		
Gasket material		Neoprene		
Contact plating		silver plated / gold plated		
Other Characteristics				
Termination technique		screw	solder	crimp
Wire gauge / AWG		max. 2,5 mm² AWG 14	0,75 mm² AWG 20	0,14 - 1,5 mm² AWG 26-16
Flammability	UL 94	VO		
Locking system		round thread		
UL	UL 1977	Conditions of acceptability		

¹⁾ DIN EN 60664-1 ± VDE 0110-1 ± IEC 60664-1

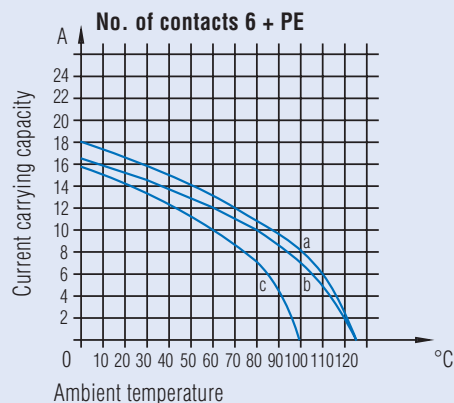

The stated technical values refer to the use as connector.

If these components are used as plug and socket device a reduced current carrying capacity has to be considered. The characteristics have to be requested from the manufacturer.

Derating Curves



all contacts under load
wire gauge 2,5 mm², 14 AWG



all contacts under load
a) wire gauge 1,5 mm², 16 AWG, stamped crimp contacts
b) wire gauge 0,75 mm², 20 AWG, stamped solder contacts
c) wire gauge 0,75 mm², turned solder contacts

Order Information

Contact plating

The standard plating is silver. Gold plated contacts are available upon request. Min order quantity = 100 pcs. per type.

Color coding

Upon request the coupling ring of the plugs and the housings of the receptacles can be delivered in the colors red, green, blue, yellow and grey. Min order quantity = 250 pcs. per type.

Mechanical coding

Achieved with special coding pins which are inserted into contact cavities. Min. order quantity = 250 pcs. per type.

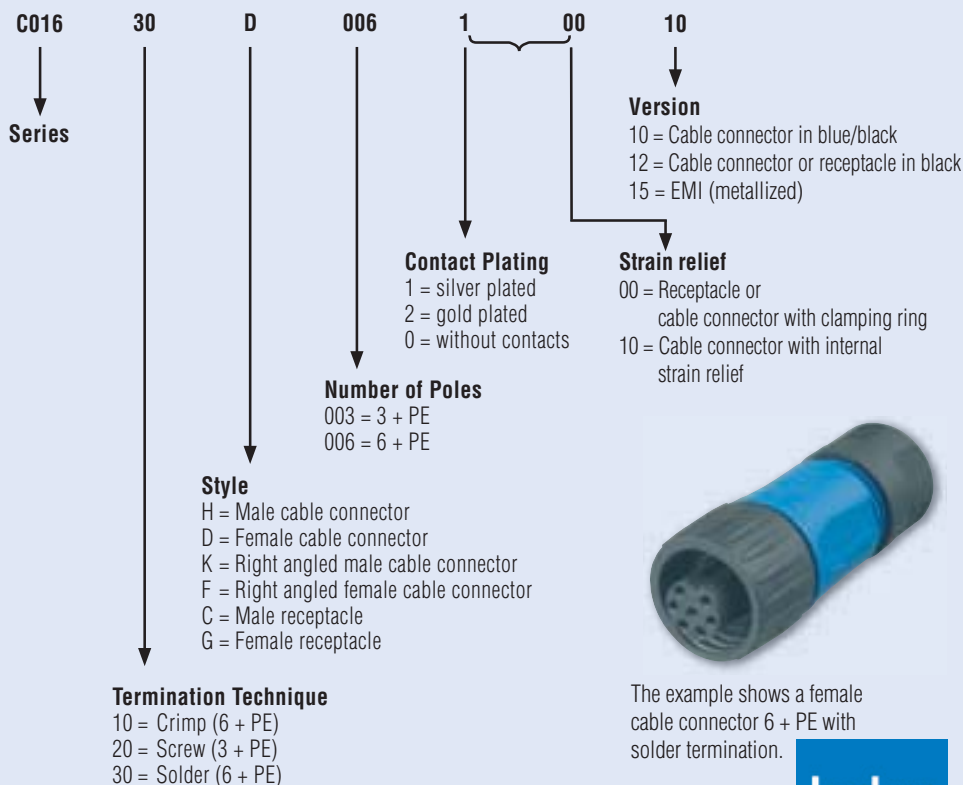
Crimp version

Order number do not include crimp contacts. Please order separately (see page 10).

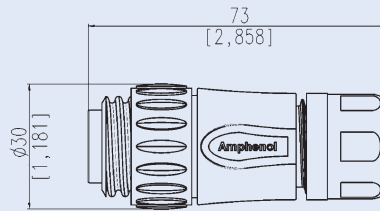
Crimp tooling

Ask for our catalogue "Tools"

Product Number Configuration

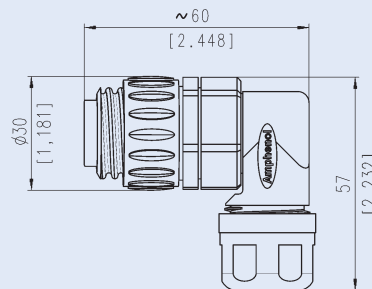


Male cable connector straight,
with internal strain relief clamp and/or
clamping ring, cable diameter 6 - 12,5 mm



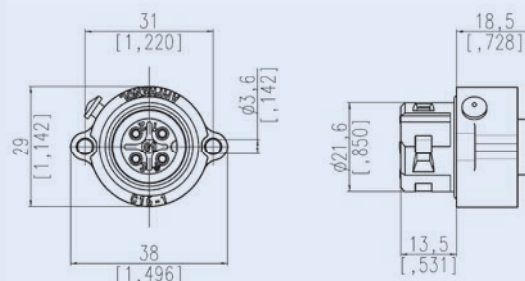
No. of contacts	Termination technique	Back shell color	Part number		Part number	
			Strain relief with clamping ring	Contact plating	Internal strain relief + clamping ring	Contact plating
			Silver plated	Gold plated	Silver plated	Gold plated
3 + PE	screw	blue	C016 20H003 100 10	C016 20H003 200 10	C016 20H003 110 10	C016 20H003 210 10
3 + PE	screw	black	C016 20H003 100 12	C016 20H003 200 12	C016 20H003 110 12	C016 20H003 210 12
6 + PE	solder	blue	C016 30H006 100 10	C016 30H006 200 10	C016 30H006 110 10	C016 30H006 210 10
6 + PE	solder	black	C016 30H006 100 12	C016 30H006 200 12	C016 30H006 110 12	C016 30H006 210 12
6 + PE	crimp ¹⁾	blue	C016 10H006 000 10	C016 10H006 000 10	C016 10H006 010 10	C016 10H006 010 10
6 + PE	crimp ¹⁾	black	C016 10H006 000 12	C016 10H006 000 12	C016 10H006 010 12	C016 10H006 010 12

Male cable connector right angled,
strain relief with clamping ring
cable diameter 6 - 12,5 mm



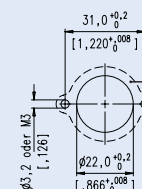
No. of contacts	Termination technique	Back shell color	Part number		
			Strain relief with clamping ring	Contact plating	
			Silver plated	Gold plated	
3 + PE	screw	blue	C016 20K003 100 10	C016 20K003 200 10	
3 + PE	screw	black	C016 20K003 100 12	C016 20K003 200 12	
6 + PE	solder	blue	C016 30K006 100 10	C016 30K006 200 10	
6 + PE	solder	black	C016 30K006 100 12	C016 30K006 200 12	
6 + PE	crimp ¹⁾	blue	C016 10K006 000 10	C016 10K006 000 10	
6 + PE	crimp ¹⁾	black	C016 10K006 000 12	C016 10K006 000 12	

Female receptacle, screw termination
(3+PE), solder termination or
crimp version (6+PE)



No. of contacts	Termination technique	Back shell color	Part number	
			Contact plating	
			Silver plated	Gold plated
3 + PE	screw	black	C016 20G003 100 12	C016 20G003 200 12
6 + PE	solder	black	C016 30G006 100 12	C016 30G006 200 12
6 + PE	crimp ¹⁾	black	C016 10G006 000 12	C016 10G006 000 12

Mounting
cut-out²⁾

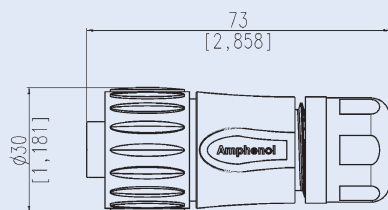


For sealing reason
this surface needs
to be level and
free of burrs.

¹⁾ Crimp contacts see page 10 / Crimp tooling see catalogue "Tools".

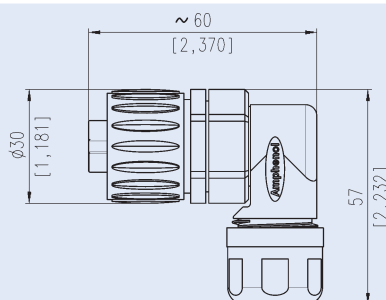
²⁾ Mounting hole Ø 22 without chamfer, suitable sealing for screws is necessary.

Female cable connector straight,
with internal strain relief clamp and/or
clamping ring, cable diameter 6 - 12,5 mm



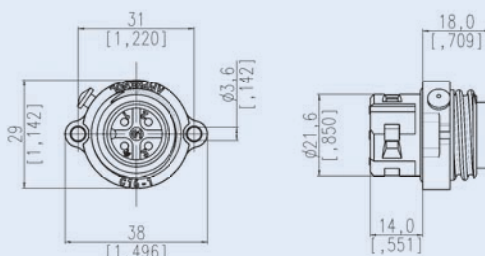
No. of contacts	Termination technique	Back shell color	Part number		Part number	
			Strain relief with clamping ring		Internal strain relief + clamping ring	
			Contact plating		Contact plating	
			Silver plated	Gold plated	Silver plated	Gold plated
3 + PE	screw	blue	C016 20D003 100 10	C016 20D003 200 10	C016 20D003 110 10	C016 20D003 210 10
3 + PE	screw	black	C016 20D003 100 12	C016 20D003 200 12	C016 20D003 110 12	C016 20D003 210 12
6 + PE	solder	blue	C016 30D006 100 10	C016 30D006 200 10	C016 30D006 110 10	C016 30D006 210 10
6 + PE	solder	black	C016 30D006 100 12	C016 30D006 200 12	C016 30D006 110 12	C016 30D006 210 12
6 + PE	crimp ¹⁾	blue	C016 10D006 000 10	C016 10D006 000 10	C016 10D006 010 10	C016 10D006 010 10
6 + PE	crimp ¹⁾	black	C016 10D006 000 12	C016 10D006 000 12	C016 10D006 010 12	C016 10D006 010 12

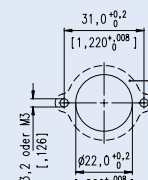
Female cable connector right angled,
strain relief with clamping ring
cable diameter 6 - 12,5 mm



No. of contacts	Termination technique	Back shell color	Part number		
			Strain relief with clamping ring		
			Contact plating		
			Silver plated	Gold plated	
3 + PE	screw	blue	C016 20F003 100 10	C016 20F003 200 10	
3 + PE	screw	black	C016 20F003 100 12	C016 20F003 200 12	
6 + PE	solder	blue	C016 30F006 100 10	C016 30F006 200 10	
6 + PE	solder	black	C016 30F006 100 12	C016 30F006 200 12	
6 + PE	crimp ¹⁾	blue	C016 10F006 000 10	C016 10F006 000 10	
6 + PE	crimp ¹⁾	black	C016 10F006 000 12	C016 10F006 000 12	

Male receptacle, screw termination
(3+PE), solder termination or
crimp version (6+PE)



No. of contacts	Termination technique	Back shell color	Part number		Mounting cut-out ²⁾
			Contact plating		
			Silver plated	Gold plated	
3 + PE	screw	black	C016 20C003 100 12	C016 20C003 200 12	 <p>For sealing reason this surface needs to be level and free of burrs.</p>
6 + PE	solder	black	C016 30C006 100 12	C016 30C006 200 12	
6 + PE	crimp ¹⁾	black	C016 10C006 000 12	C016 10C006 000 12	

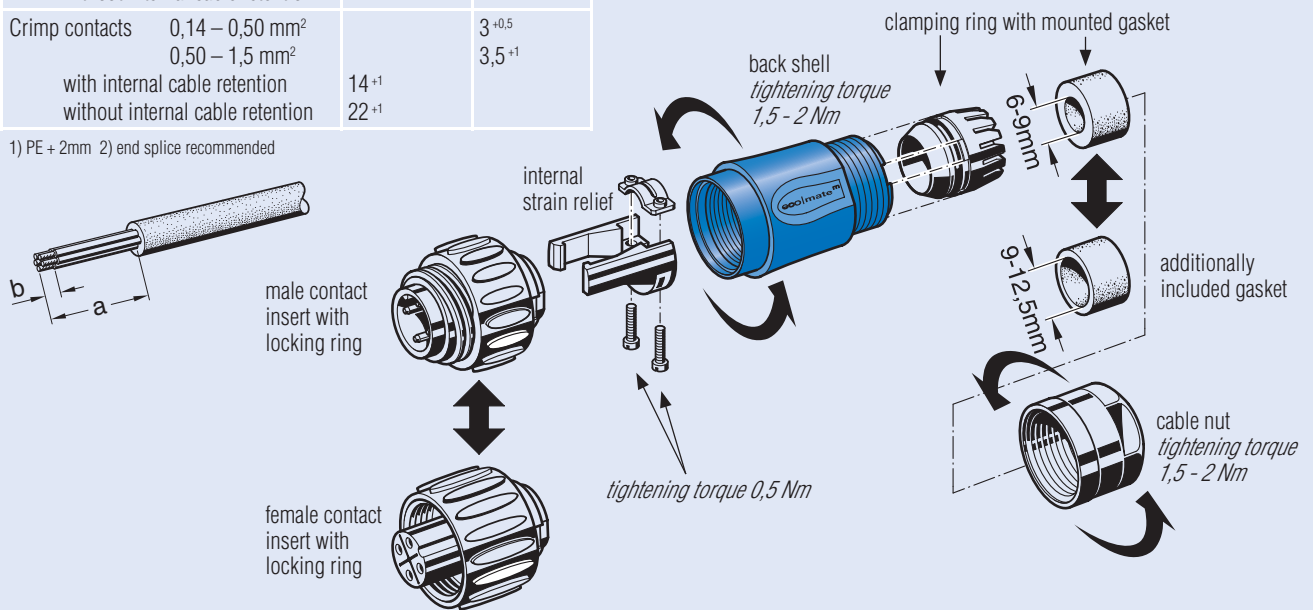
¹⁾ Crimp contacts see page 10 / Crimp tooling see catalogue "Tools".

²⁾ Mounting hole Ø 22 without chamfer, suitable sealing for screws is necessary.

Mounting Instruction, straight cable connector

Stripping Lengths	Measure a ¹⁾	Measure b
Screw contacts		
with internal cable retention	18 ⁺¹	7 ^{+1 2)}
without internal cable retention	25 ⁺¹	7 ^{+1 2)}
Solder contacts		
with internal cable retention	14 ⁺¹	4 ⁺¹
without internal cable retention	22 ⁺¹	4 ⁺¹
Crimp contacts		
0,14 – 0,50 mm ²		3 ^{+0,5}
0,50 – 1,5 mm ²		3,5 ⁺¹
with internal cable retention	14 ⁺¹	
without internal cable retention	22 ⁺¹	

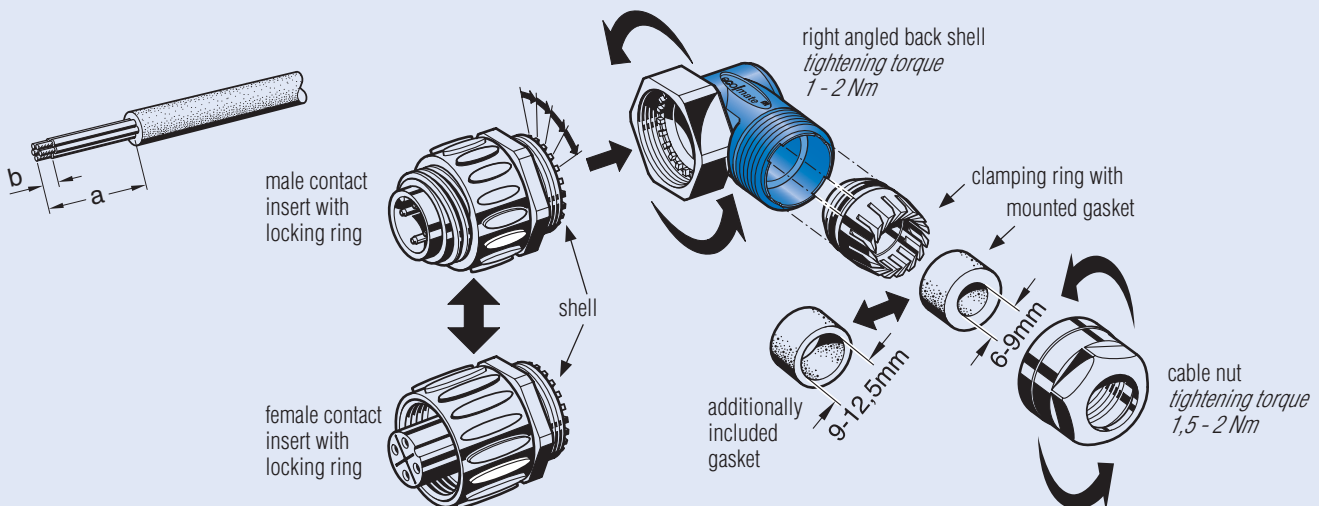
1) PE + 2mm 2) end splice recommended



Mounting Instruction, right angled cable connector

Stripping Lengths	Measure a ¹⁾	Measure b
Screw contacts		
without internal cable retention	35 ⁺¹	7 ^{+1 2)}
Solder contacts		
without internal cable retention	32 ⁺¹	4 ⁺¹
Crimp contacts		
0,14 – 0,5 mm ²		3 ^{+0,5}
0,50 – 1,5 mm ²		3,5 ⁺¹
without internal cable retention	32 ⁺¹	

1) PE + 2mm 2) end splice recommended





1. General Remarks

These connectors are designed and produced in conformity with the low voltage directive (73/23/EWG) respectively Gerätesicherheitsgesetz (German law) and are especially in accordance with the standards DIN EN 61984 / IEC 61984 (VDE0627); IEC 60664-1 (VDE 0110-1) and IEC 60529.

The connectors may be used only within the technical ratings.

All technical data refer to mated connectors under live conditions.

The safety of the connector system depends on the correct selection of products, proper assembly of the connector device and a precise fit of the connectors.

2. Application Remarks

Connectors with / without breaking capacity must be used according to specified technical ratings.

The technical data represents the initial value of mated parts under predetermined conditions and length of time. These values could change with different test parameters or product requirements.

The connectors of the eco|mate^m series are designed for the areas of application including the construction and installation of controlling and electrical devices.

The product has been tested for the intended purposes only. If the connection is used other than originally intended, or in another manner that we have not previously tested, the consumer assumes full responsibility.

All rated data for the connectors listed in this catalogue are based on over-voltage category III ¹⁾ and pollution degree 3 ²⁾ for electronic applications. Connectors were completely mated according to their respective safety locking mechanism. Selection and testing of connectors with / without breaking capacity to meet specific product or industrial requirements such as rated voltage and the related clearances and creepage distances are the responsibility of the user.

3. Assembling Remarks

Protection against electrical shock of the termination of the connectors shall be secured by correct mounting. Connectors of the same or different series being mounted side by side may be protected against incorrect mating by the use of coding options. Care must be taken to ensure the parts are correctly mated and screws are tightened with the proper torque.

4. Termination Remarks

Cable connectors are effectively secured when using the strain relief (internal strain relief clamp or clamping ring). When the connector contains a simple gland bushing for retention without clamping ring the cable should have a strain relief close behind the connector. All cable properties or specifications must be compatible with the connector design and materials.

Designated wire conductors must be terminated to the correct poles in the connector.

Crimp contacts must be fully inserted into the plastic housing and strain relief assured with a slight tug on the wire.

Wire should be stripped correctly according to printed specifications to insure no electrical contact can be made between the conductors. There should be no nicked or cut strains during the stripping action.

5. Safety Classification acc. to DIN EN 61984 / VDE 0627 / IEC 61984

Style	enclosed mated	enclosed unmated	protective earthing contact	finger safety mated	finger safety unmated	hand back safety mated	connector with breaking capacity ¹⁾	rewirable	Cable clamp	
									with	without
Male cable connector	•	•	•	•	NA	•	•	•	•	•
Female cable connector	•		•	•	•	•	•	•	•	•
Male receptacle screw / crimp	•	•	•	•	NA	•	•	•		•
Female receptacle screw / crimp	•		•	•	• ³⁾	•	•	•		•
Male receptacle solder	•	•	•	• ³⁾	NA	• ³⁾	•	•		•
Female receptacle solder	•		•	• ³⁾	• ³⁾	• ³⁾	•	•		•

¹⁾ Overvoltage category III: Equipment intended for the use in installations or parts of it in which lightning overvoltages do not need to be considered, however switching overvoltages generated by the equipment, and for cases where the reliability and the availability of the equipment or its dependent circuits are subject to special requirements. Examples are protecting means, switches and sockets.

²⁾ Pollution degree 3: Conductive pollution occurs or dry non-conductive pollution occurs which becomes conductive due to condensation which is to be expected.

³⁾ Protection against electrical shock of the termination of the connectors shall be secured by correct mounting.

NA ≙ not applicable